ORGANIZATIONAL BEHAVIOR AND HUMAN DECISION PROCESSES 37, 157–187 (1986)

Group Processes in Computer-Mediated Communication

JANE SIEGEL, VITALY DUBROVSKY, SARA KIESLER, AND TIMOTHY W. MCGUIRE

Carnegie–Mellon University

Three experiments explored the effects of computer-mediated communication on communication efficiency, participation, interpersonal behavior, and group choice. Groups of three members were asked to reach consensus on career choice problems; they communicated face-to-face and in simultaneous computer-mediated discussions or through computer mail. When groups were linked by computer, group members made fewer remarks than they did face-to-face and took longer to make their group decisions. Social equalization was higher in computer-mediated groups in that group members participated more equally in discussions. Computer-mediated groups also exhibited more uninhibited behavior—using strong and inflammatory expressions in interpersonal interactions. Decisions of computer-mediated groups shifted further away from the members' initial individual choices than group decisions which followed face-to-face discussions. We discuss the implications of these findings for extension of theories about group interaction and for analyses of the effects of computers in organizations. © 1986 Academic Press, Inc.

As national and local computer networks proliferate, computer-mediated communication may become a mainstay of organizational communication. The growth of networks is stimulated by rapidly decreasing costs and by the advantages of networks over stand-alone computer systems, such as sharing high-speed printers or provision of a common interface for otherwise incompatible equipment, enabling rapid exchange of documents, data bases, and messages. Computer mail, computer conferences, electronic bulletin boards, blackboards, and file transfer systems are fast being adapted for nontechnical users (e.g., Johansen, Vallee, & Spangler, 1979; Licklider & Vezza, 1978; Schneiderman, 1979;

This research was supported by grants from the Robotics Institute, Carnegie–Mellon University, and from the National Science Foundation (IST-8210701) to Sara Kiesler. We are grateful to Chuck Augustine, William Eddy, Lionel Galway, Kay Hofmeister, John Stuckey, and David Zubrow for assistance in developing procedures for this research. Gema Barkanic, Nora Dugal, Judith Hammer, Kay Hofmeister, Jeff Jury, Wendy Kobee, Anne Marie Moses, Frank Scibilia, Arlene Simon, and Lori Zuti collected and analyzed data. We thank Rob Kling, Allen Newell, Beau Sheil, Drury Sherrod, Lee Sproull, and anonymous reviewers for useful comments on drafts of this article. Send reprint requests to Dr. Sara Kiesler, Department of Social Sciences, Carnegie–Mellon University, Schenley Park, Pittsburgh, PA 15213.

0749-5978/86 $3.00

Turoff, 1982a). Even now, the older national networks (ARPANET, TELENET) and some more recent intraorganizational applications (e.g., Nestar System's CLUSTERBUS, Xerox's ETHERNET, Ford Aerospace's FLASHNET, Wang Laboratories' WANGNET, IBM'S VNET) are used for group problem solving and forecasting, consensus development, coordination and operation of group projects, sharing ideas and gossip, and mobilizing organizational action within special forums or interest groups (Hiltz, 1982; Tapscott, 1982; Vallee, Johansen, Lipinski, & Wilson, 1977). From these applications, the new communication technologies using computers would seem likely to have major effects on work and the organization of work. Thus, it seems sensible to study the behavioral and social implications of using computer-mediated communication.

Research on the behavioral and social effects of computers used for communication falls into four general categories—technology assessment studies, organizational studies, technical capabilities studies, and social psychological studies. Technology assessment studies evaluate the potential impact of computer networks on society or on a given societal institution such as education or libraries (Hiltz & Turoff, 1978; Lancaster, 1978). Organizational studies examine the impact of computer-mediated communication on jobs and job performance and managerial functioning (e.g., Bikson & Gutek, 1983; Christie, 1981; Hiltz, 1982; Rice, 1980; Zuboff, 1982). Technical capabilities studies investigate the relative ease or difficulty with which people learn or carry out particular communication operations as a function of network or software variables (e.g., Thomas & Carroll, 1981; Turoff, 1982a). Social psychological studies investigate such issues as the social or organizational context in which people communicate and the effects of computer-mediated communication on interpersonal relations (e.g., Chapanis, 1972; Hiltz, Johnson, Aronovitch, & Turoff, 1980; Kiesler, Zubrow, Moses, & Geller, 1983; Short, Williams, & Christie, 1976; Williams, 1975).

The present study, an examination of the process and consequences of using computer-mediated communication in groups, falls into this fourth category. Little is known as yet about the effects on groups of using modern computer networks for communication. This study was designed to address one question raised by the research that does exist, that is, does computer-mediated communication change group decision making? This question has been discussed by commentators interested in the effects on group productivity of using computers (e.g., Crawford, 1982; Price, 1975). The question also has application to theories of group behavior, in that computer-mediated communication comprises a unique set of communication characteristics which have been associated with decision-related group processes in previous research.

In situations where groups make decisions, different aspects of com-

munication behavior may be of interest, including (1) communication efficiency, (2) participation of group members, (3) interpersonal behavior, and (4) consensus development and group choice. We consider each of these aspects in turn, and examine how computer-mediated communication may affect the phenomena.

Communication efficiency, as we define it, refers to group members' capability to function, or to communicate data, ideas, opinions, and feelings among themselves in the least wasteful manner. We include under this general concept of efficiency such measures of communication as the time required to reach consensus, the number of remarks exchanged by group members, the number of task-oriented remarks as a fraction of total remarks, and the number of decision proposals as a fraction of total remarks (a rough operationalization of getting the point across in the fewest words).

The expected effect of computer mediation on communication efficiency is ambiguous. Since computer-mediated communication is both fast and flexible, the technology may make possible efficient exchange of task information, without the some of the inefficiencies found in meetings (e.g., waiting for everyone's attention, taking turns in speaking, giving social support, distributing written materials). With computer mediation, messages can be sent simultaneously and instantly. They can include information which is otherwise presented on paper, as well as in conversation. The messages can be of any formality; there are no technical limits on length, number of group members included in messages, or geography, if group members are separated.

In addition to its capability of transmitting text instantly, computer-mediated communication may have social psychological advantages for efficiency. First, the speed and flexibility of computer-mediated communication might increase subjective feelings of control and focus attention on the task. Second, in computer-mediated communication, written text is the only channel. Communication via computer lacks aural and visual cues and social context information one obtains in face-to-face or telephone communications. (Even letters typed on letterhead convey more social context information.) This implies that the information conveyed in words will be salient rather than the group or individuals with whom one is communicating.

Computer mediation also might reduce communication efficiency. In the first place, typing and reading is probably more difficult than speaking and listening. Second, several lines of previous research suggest that inhibiting the flow of social feedback, especially "backchannel" feedback, feelings, and social meanings decreases the efficiency of interpersonal communication. For instance, not being able to nod one's head to indicate understanding or to murmur "hmm" impedes one's ability to com-

municate comprehension of the other person's message efficiently (Kraut & Lewis, 1984; Kraut, Lewis, & Swezey, 1982). Lack of nonverbal or auditory information also interferes with the exchange of feelings (e.g., Carnevale, Pruitt, & Seilheimer, 1981; Krauss, Apple, Morencz, Wenzel, & Winton, 1981). This implies that fast electronic exchanges between two or more people could, at least functionally, transform two-way (or multiway) conversations into multiple monologues, with the result that communication becomes inefficient. Further, any communication inefficiencies which resulted from this nonexchange of backchannel feedback among people might be exacerbated by the absence of nonverbal cues for regulating turn-taking, intentions to speak further, and for controlling other procedural aspects of participation (Short *et al.*, 1976, pp. 77–89).

Participation of group members refers to the distribution of communication in the group. In many groups, participation is unequal, and the proportion of participation is predicted by group members' social position and personal competencies (Bales, Strodtbeck, Mills, & Roseborough, 1951). For example, signs of people's external status elicit status generalization, the tendency for group members to respond to the external status of a group member (Humphreys & Berger, 1981). Communication via computer lacks mechanisms for displaying or enforcing social differentiation among people (for example, in the way taking the head seat at a face-to-face meeting differentiates a chairperson, or eye contact helps a person dominate a conversation). The loss of this differentiating social information might reduce the social influence function of communication (Edinger & Patterson, 1983; Patterson, 1982). Our reasoning is that if computer-mediated communication focuses attention on text, and if it fails to communicate differentiating social cues such as high external status or a personally dominating style, then participation rates should be more equal.

Interpersonal behavior refers to overt expressive behavior which is, or seems to be, affective in tone (such as insulting, laughing, shouting) and is relevant to such issues as how a group deals with conflict and whether it promotes uninhibited or antisocial group behavior.

The relative absence of social context information and social feedback in computer-mediated communication might lead to uninhibited behavior because these gaps are not yet replaced by shared norms for conveying or interpreting the social meaning of what is communicated. Although computer professionals have used computer communication for two decades, and they comprise a subculture whose norms influence computer users and computer communication, no strong etiquette as yet applies to how electronic communication should be used (Brotz, 1983; Johansen *et al.*, 1979). For instance, there seem to be no standards for the use or nonuse of salutations (Safire, 1983), for appropriate people to whom computer

mail is copied or forwarded, for times when messages are to be sent or answered, and for limiting discussion of intimate subjects. For the purpose of conveying personal and social meaning and for imposing social structure, an etiquette and set of social ethics for electronic communication is still to be developed.

If technical and social characteristics of computer-mediated communication act to impede the communication of social context information, one result might be depersonalization of the situation and behavior. In previous research, it has been found that nonverbal involvement and social cues from, for example, dress, location, demeanor, and expressiveness convey individuating details about people which capture attention and increase concern for them (e.g., Ekman, Friesen, O'Sullivan, & Scherer, 1980; Mehrabian, 1972). The more communication depends on text, and the less the nonverbal or auditory involvement, the more depersonalization seems to result (Sinaiko, 1963; Williams, 1977). Indeed, except that it involves submergence in a technology rather than submergence in a group, computer-mediated communication includes some of the same conditions important for one kind of depersonalization experience, deindividuation (e.g., Diener, 1979; Festinger, Pepitone, & Newcomb, 1952; Prentice-Dunn & Rogers, 1979). In deindividuation, reduced attention to self and others elicits behavior that is relatively unrestrained and unregulated (Carver & Scheier, 1981, pp. 171–176). We believe that computer-mediated communication, in comparison to face-to-face communication, will reduce feelings of embarrassment, guilt, and empathy for others; produce less social comparison with others; as well as reduce fears of retribution or rejection. This technologically-induced "deindividuation" should lead to greater uninhibited behavior in computer-mediated group decision processes.[1]

[1] Many anecdotal reports of uninhibited (counternormative) behavior in computer networks circulate on computer bulletin boards and in computer-related publications. In the network community, "flaming" refers to the expression of strong and inflammatory opinions to others electronically. Flaming persists on the 13-year old Defense Communications Agency-supported ARPANET, and ARPANET electronic bulletin boards have to be policed manually. When IBM installed the personal computer in its offices and created an internal message system, VNET, to link them, a "GRIPENET" emerged—an electronic underground newsletter in which complaints which deviated considerably from the organization's typical norms were aired against management practices and policies (Emmett, 1981). COMPUSERVE, which is a private network of microcomputer owners, is reported to foster various forms of flaming and uninhibited behavior, ranging from sexual overtures via computer to consciousness raising (Van Gelder, 1983). These anecdotes are not necessarily indicative of a causal relationship between using computers for communication and uninhibited behavior, but they suggest that such behavior may result from using the technology.

Group choice is an outcome of consensus development, a process of resolving conflict so as to permit a group decision (Davis, Holt, Spitzer, & Stasser, 1981; Lamm & Myers, 1978). One set of tasks of this type are the "choice shift" experimental tasks where groups must develop a consensus regarding career choices which vary in risk (Dion, 1978; Kogan & Wallach, 1967; Lamm & Kogan, 1970; Stoner, 1961).

There has been debate over the reason for choice shift, centering on two proposals: (1) persuasive arguments theory which argues that choice shift is caused by partially shared arguments for the initially favored alternative (Vinokur & Burnstein, 1974, 1978) and (2) social comparison theory which argues that shift occurs when group members realize their positions were not as extreme as those of others (e.g., Jellison & Arkin, 1977). This comparison can be produced either by group discussion, or when group members simply visualize the positions of group members or external reference group norms (e.g., Cvetkovich & Baumgardner, 1973; Nagao, 1983). Hence, one theory emphasizes informational social influence and the other emphasizes normative influence.

The expected impact of computer-mediated communication on choice shift is unclear. We believe that the absence of social context cues in computer mediation will reduce normative influence relative to informational influence. This should reduce the impact of implicit reference group norms and of group members' social approval of one another, and increase the importance of arguments or decision proposals actually contained in messages exchanged in the group. Decisions in the computer-mediated group should be more volatile than decisions in face-to-face groups, and they should move farther away from earlier preferences.

Existing research does not bear directly on the role of communication modality in choice shift. Nonetheless, there is some information. First, other decision tasks, such as bargaining, tend to be sensitive to communication modes which reduce nonverbal or other social feedback. Without social cues, group members have less ability to control or manage the interaction (Edinger & Patterson, 1983; Short *et al.,* 1976, pp. 91–99). In early research on interaction using written messages, opinion change was more frequent and greater than that obtained in face-to-face interaction (Festinger, 1950). Moreover, message content had more impact on opinion change than communicator characteristics (e.g., likability) when message cues rather than people cues were made salient (Chaiken & Eagly, 1983). This research suggests that computer-mediated communication might exacerbate group choice shifts away from initial member preferences because it focuses attention on recent arguments or decision proposals contained in the messages. Of course, if messages reminded group members of their previous preferences, they should shift less; we do not expect groups to dwell on the past, however.

The purpose of the present study was to examine these ideas experimentally. Recent commentaries on computer-mediated communication are concerned with the efficiency and effectiveness of information exchange in computer-linked groups. Computer-mediated communication is portrayed in vendor and popular publications as a technological marvel for increasing group information and productivity. We thought it useful to examine an alternative premise: that computer-mediated communication is a complex but fundamentally understandable intervention in interpersonal interaction which systematically alters group decision making.

From our observations and the social psychological literature, we developed four working hypotheses:

1. Groups using computer-mediated communication to make decisions will exchange fewer remarks during group discussion, and will take longer to reach consensus, than these groups will when they use face-to-face communication. However, in computer-mediated groups, a higher proportion of the discussion remarks might be task oriented and explicit decision proposals.
2. Group members using computer-mediated communication to make decisions will participate more equally in group discussions than will group members engaged in face-to-face group discussions.
3. Uninhibited behavior will occur more frequently in computer-mediated communication than in face-to-face communication.
4. Choice shift (group choices different from initial individual choices) will be greater following computer-mediated communication than it will be following face-to-face communication.

We designed three experiments comparing computer-mediated with face-to-face communication in three-person groups. In a repeated measures design, groups used both computer-mediated and face-to-face communication to reach consensus on choice-dilemma problems which involved selecting acceptable levels of risk for attractive but risky career decisions.

The experiments reported below were conducted in the liberal arts college of Carnegie–Mellon University, which prides itself on its advances in computing. Currently 83% of the student body has a computing account; the average weekly computer use per student is 1.5 h of connect time. Every liberal arts student is required to take an introductory programming course (usually PASCAL), and many other courses make use of the computer. The most frequently used computer programs, in and out of classes, are the communication and editing programs run on a time-shared network. This use is encouraged by the general availability of computer terminals. Hence, the research to be reported was conducted in a relatively computer-intensive environment, where people are

familiar with computers and think using them is a normal work and life activity. The experiments were carried out in ordinary offices and terminal rooms on the university campus. The subjects were undergraduates who had prior computing experience (had taken a computing course and used the computer mail system, and/or learned a programming language).

EXPERIMENT 1

Method

Subjects. Fifty-four students (26 males and 28 females) participated in this experiment. About one-third of the students were paid for participating in the study and the rest participated as part of a class exercise. The subjects were scheduled in 18 groups of three and were randomly assigned to conditions. With a few exceptions, the subjects were not acquainted with one another prior to the experiment. As noted before, all of the subjects used computers interactively. However, none of them had used the computer to communicate simultaneously with others as was required of them in this study.

Design and procedure. Groups were asked to come to consensus on a different choice-dilemma problem in three different contexts, once face-to-face (seated at a table in an office or classroom), once using the computer anonymously (that is, not knowing by name who within their group was talking), and once using the computer nonanonymously (typing their names in the section designated for their own comments). The design of the experiment was a 3×3 (communication condition $\times$ problem) repeated measures Latin square, with order of communication condition and order of problems balanced separately but not jointly.

In the computer-linked conditions, the subjects were separated physically, and each used a computer terminal (CRT) with keyboard. Each subject's view of the screen included any text he or she typed along with the text typed from remote locales by the two other people in the group. Figure 1 portrays what subjects first saw when they were seated at their terminals. To discuss a choice-dilemma problem with others, the subjects used an interactive software program for on-line synchronous communication. The program, called "Converse," is a regular feature of the computer network at the university (and also of various national networks). Converse splits the computer screen into windows for each person in the group so that each person can read the message he or she is sending as well as the other group members' mesages. Once the computer discussion has begun, each window scrolls independently so that group members need not wait to see other people's responses before typing their own. Messages are sent automatically the instant they are typed without anyone having to operate any controls.

First Screen

```
Hello! This is the computer portion of the group discussion. As in
the face-to-face discussion, you will be conversing with the 2 other
members of your group. In a few minutes you will automatically enter the
program which allows you to converse.

All you have to do to talk is type in any message and it will appear on
the screen in one of five partitioned boxes. Here is how the boxes will
look:

VDOE  |
TTY   |
2     |
------|----------------------------------------------------------------
VDOE  |
TTY   |
3     |
------|----------------------------------------------------------------
There will be three more boxes as well.
```

Second Screen

```
When the other group members also type messages, the cursor (little white
box which is typing out these characters) will move around. Sometimes
it will not type in your message until it has completed someonelse's. Or
it will move back and forth between the boxes. Just keep typing and event-
ually your entire message will appear in the box.

When your box is full, the cursor will once again start at the top but it
will not erase the lines below it until you type some more. Here's what I
mean:

VDOE  | There are four lines to work with. Suppose I have a lot to say
TTY   | and fill them all up with my ideas. Once the last line is full,
2     | the cursor will move back up to the top of the box and continue
      | to type out your message on the top line.
------|----------------------------------------------------------------
VDOE  | But it will leave the last three lines alone until there is no
TTY   | and fill them all up with my ideas. Once the last line is full,
3     | the cursor will move back up to the top of the box and continue
      | to type out your message on the top line.
```

Third Screen

```
VDOE  | But it will leave the last three lines alone until there is no
TTY   | more room left and it has to move to the second line.
4     | the cursor will move back up to the top of the box and continue
      | to type out your message on the top line.
------|----------------------------------------------------------------

I know it's a little confusing so be sure and pause after you have filled
up your box to give the others a chance to read and also to read their
messages.

The information in the smaller boxes on the left is simply the user-id pf
the person using that box. It can be ignored.

After ten minutes of discussion time, you will be told that it is time
to reach a decision and enter it into your box. At the end of the discussion
you will exit the program by hitting the button marked "CTRL", and at the
same time holding down "C". You will be told when to do this. When the
time is up you will receive instructions about the next portion of the
experiment.
```

FIG. 1. Terminal display.

There were four parts to the experiment. First, the subjects privately completed a questionnaire for each of the three problems they would encounter in the group; then they met in each of the three communication conditions to consider each of the three problems. The groups were instructed to discuss the choice and to come to consensus within 10 min (they were allowed to continue for up to 20 min, but reminded to make a decision after 10 and 15 min). In the face-to-face communication condition, subjects were seated around a table and tape-recorded (the resulting transcripts were typed into computer files for use in content analyses). In the computer-mediated communication conditions, subjects were escorted out of hearing and sight of others, placed at terminals, and logged into the simultaneous conversation program. They were told that the discussions would be recorded automatically by the computer.

Dependent measures. The raw data generated in this experiment consisted of numeric decisions by individuals and groups and of complete transcriptions of both face-to-face and computer-mediated discussions. We were interested in four main variables: communication efficiency (time to consensus, number of remarks, task-oriented remarks, and decision proposals as proportions of total remarks), social equalization (equal participation in group discussion), uninhibited communication, and choice shift. To evaluate communication efficiency of talk we measured the number of separable units of thought, "remarks," that subjects exchanged during the group discussion and the time in minutes it took groups to reach consensus. Two coders independently divided subjects' statements into remarks, according to the coding guide developed for the study shown below:

1. Each remark is comprised of a clause (subject, verb, object);
2. Count statements of proper names, but tally them separately from total remarks/participant;
3. For sentences containing "if" "then" or other conditional clauses where the "then" clause depends on the outcome, count it as one remark;
4. Unintelligible/incomplete remarks such as "I think" or "mumble" are not counted;
5. Remarks where one specific subject (person) cannot be tied to a remark are omitted, e.g., on audio tapes where a remark is transcribed as "All: Yea" it should not be counted;
6. Electronic mail "Subject:" responses are counted if they are more than two words or convey information about the group's choice, e.g., "Mr. H" or "Decision" are not counted, but "4 in 10" or "agreed" are counted;

7. Verbal ticks such as "ya know" are not counted when they occur within sentences, only if they come at the beginning or end of a remark in the form of a question or affirmative assertion.

In addition to counting all remarks, the coders also counted three subclasses of remarks. The first category, task-oriented remarks, was used in calculating one measure of communication efficiency. The coding instructions defined task-oriented remarks as those which related to the decision process or content. For example, "let's keep to the subject" or "I think Mr. H's chances are 3 in 10" were considered task oriented, but "Hey, what about a beer afterwards" or "what color is your hair" were not. A second category, decision proposals, consisted of a count of the number of times group members suggested one of the numeric risk decision alternatives (e.g., "I think we should go for 3/10.") A third category, uninhibited behavior, was the number of remarks containing swear words, name-calling, and insults (e.g., "you jerk" or "you fool").

The coders used transcripts from pilot experiments to develop the coding guide. They practiced until they differed in no more than one phrase (remark) per transcript. Then, in cases where the coders disagreed, they discussed and resolved differences together. Detailed lists of all examples of uninhibited and task-oriented remarks were generated and reviewed for consistency and comprehensiveness. We had to omit a few subjects' transcripts from the analyses because of technical problems (e.g., audiotapes with unaudible sections or computer mail exchanges where two subjects accessed one directory by mistake and wrote comments under the same identity).

To evaluate social equalization, we measured the distribution of remarks among group members. We calculated the inequality of participation in two ways, (1) by using the standard deviation of the number of remarks per group member, and (2) by measuring the average relative standard deviation of group members' participation rates. The latter is a summary inequality measure (I) directly proportional to the sample standard deviation of the proportions, where the proportionality constant was chosen so that the measure varied between zero (equal participation) and unity (maximum inequality, i.e., where only one group member makes remarks):

$$I = [M/(M - 1)N]\left[\sum_{i=1}^{N}\sum_{j=1}^{M}(P_{ij} - 1/\mathrm{M})^2\right],$$

$$\text{where i} = 1, \ldots, N, j = 1, \ldots, M \qquad (1)$$

To evaluate choice shift we used numeric preferences ranging from 1/10

to 9/10 (level of risk required to choose the attractive alternative) as in previous studies of choice-dilemma problems. For example:

> I recommend that Mr. H. attend the conservatory if the chances are 9 in 10 that he will succeed as a concert pianist.
>
> I recommend that Mr. H. attend the conservatory if the chances are 1 in 10 that he will succeed as a concert pianist.

Each group, after discussion, had to agree on one of the responses, and the absolute difference[2] between individual choices prior to discussion and the group's choice was the measure of choice shift. In this experiment we deviated from usual practice in one respect, that is, in order to encourage conflict in the three-person groups we restricted possible responses to 1/10, 3/10, 5/10, 7/10, and 9/10 (1/10 is the riskiest choice).

To ensure that we measured different aspects of group decision making, we tested for intercorrelations among the dependent measures using the Pearson r. These are shown in Table 1. As may be observed, alternative measures of efficiency (proposals relative to remarks in the opposite direction) and of participation were correlated with one another. Overall, the correlations suggest substantial independence among the different dependent measures.

The data were analyzed using BMDP3V software for mixed models Latin square repeated measures designs. Our results are based on maximum likelihood statistics which have asymptotic χ^2 distributions, where the degrees of freedom of these statistics are shown as df_N in expressions of the form $df = df_N/df_D$. The number df_D is the denominator degrees of freedom of what would have been the F statistic to test the hypothesis of interest in a conventional ANOVA model (i.e., df_D is the number of observations minus the number of degrees of freedom used up in estimating the parameters of the model other than variances and covariances).

Results

The main data from this experiment, as well as relevant summary statistics, are presented in the left-hand columns of Table 2. At the outset, the two computer-mediated communication conditions (anonymous versus nonanonymous) did not differ significantly, which is probably not surprising since anonymity meant only that a group member did not know which of the other two subjects was making which remarks. Also, problem type had no main effects and in only one instance was there a

[2] Since we were interested in the magnitude (not the direction) of choice shift, we compared, for each communication condition, the absolute difference scores reflecting changes from the average of group members' initial individual preferences to the group choice.

TABLE 1
INTERCORRELATIONS AMONG DEPENDENT MEASURES

Measure	2	3	4	5	6	7	8
			Experiment 1 (n = 42)				
1 Time	.20	.40	−.11	−.07	−.43	.18	.13
2 Total remarks		.84	−.44	.68	.01	.11	−.04
3 Task rem/total			−.31	.57	−.01	.01	.11
4 Proposals/total				−.32	−.03	.08	.05
5 Inequality (*SD*)					.62	.18	−.15
6 *SD*/total remarks						−.19	−.10
7 Uninhibited remarks							.08
8 Choice shift							
			Experiment 2 (n = 24)				
	2	3	4	5	6	7	8
1 Time	−.15	.66	.43	.36	−.22	.14	−.38
2 Total remarks		.35	.40	−.07	−.37	−.01	.25
3 Task rem/total			.60	.38	−.10	.34	.08
4 Proposals/total				−.33	−.25	−.16	−.16
5 Inequality (*SD*)					.91	−.25	−.38
6 *SD*/total remarks						−.28	−.35
7 Uninhibited remarks							.50
8 Choice shift							
			Experiment 3 (n = 36)				
	2	3	4	5	6	7	8
1 Time	−.07	−.19	−.38	.22	.24	.18	.07
2 Total remarks		.97	−.35	.38	−.26	.08	−.03
3 Task rem/total			−.20	.34	−.26	.03	−.01
4 Proposals/total				−.38	−.11	−.05	−.10
5 Inequality (*SD*)					.67	−.08	−.04
6 *SD*/total remarks						−.10	−.13
7 Uninhibited remarks							−.20
8 Choice shift							

problem type × communication condition interaction. Finally, we found no main effects due to order or to sequence of conditions.[3]

The communication conditions (face-to-face vs computer-mediated) significantly affected communication efficiency, the distribution of partic-

[3] In the Latin square design, communication condition, problem, order of communication condition, and order of problem are confounded. Hence, there is no general test of whether there are order of communication condition or order of problem effects. Although one could execute a 4-degree-of-freedom test for interactions between order of communication condition and order of problem, to do so seemed to us to miss the point. We chose not to try to test for these effects, relying rather on our strong belief that there is no good a priori reason for such effects, especially since the design was counterbalanced for order of communication condition and order of problem effects separately (but not jointly).

TABLE 2
COMMUNICATION BEHAVIORS

Measures	Experiment 1			Experiment 2		Experiment 3		
	FF	CCN	CCA	SIM	SEQ	FF	CCN	EM
Communication efficiency								
Time[a]								
Mean	0.06	0.16	0.17	0.34	0.29	0.10	0.33	0.38
SD	0.06	0.09	0.08	0.09	0.10	0.06	0.12	0.14
χ^2 (condition)	$(2, N = 48) =$	16.7		$(1, N = 24) = 1.9$			$(2, N = 54) = 42.9$	
$p \leqslant$		.01		n.s.			.01	
χ^2 (problem)	$(2, N = 48) =$	1.47		$(1, N = 24) = 0.04$			$(2, N = 54) = 0.04$	
$p \leqslant$		n.s.		n.s.			n.s.	
χ^2 (condition × problem)	$(4, N = 48) =$	2.13		$(1, N = 24) = 1.58$			$(4, N = 54) = 3.52$	
$p \leqslant$		n.s.		n.s.			n.s.	
Remarks[b]								
Mean	14.24	8.39	10.50	20.42	15.14	32.71	17.61	14.96
SD	13.96	6.14	5.99	5.86	5.31	21.40	7.82	6.88
χ^2 (condition)	$(2, N = 42) =$	12.8		$(1, N = 24) = 7.40$			$(2, N = 48) = 15.75$	
$p \leqslant$		.01		.01			.01	
χ^2 (problem)	$(2, N = 42) =$	1.31		$(1, N = 24) = 0.02$			$(2, N = 48) = 3.26$	
$p \leqslant$		n.s.		n.s.			n.s.	
χ^2 (condition × problem)	$(4, N = 42) =$	5.99		$(1, N = 24) = 8.07$			$(4, N = 48) = 7.61$	
$p \leqslant$		n.s.		n.s.			n.s.	

Task-oriented remarks/total[c]								
Mean	0.67	0.74	0.73	0.66	0.66	0.97	0.83	0.96
SD	0.31	0.33	0.26	—	—	0.06	0.19	0.10
χ^2 (condition)	$(2, N = 42) = 2.01$			$(1, N = 24) = 2.29$			$(2, N = 48) = 23.16$	
$p \leq$	n.s.			n.s.			.01	
χ^2 (problem)	$(2, N = 42) = 0.45$			$(1, N = 24) = 0.01$			$(2, N = 48) = 2.53$	
$p \leq$	n.s.			n.s.			n.s.	
χ^2 (condition × problem)	$(4, N = 42) = 1.84$			$(1, N = 24) = 0.60$			$(4, N = 48) = 8.66$	
$p \leq$	n.s.			n.s.			n.s.	
Decision proposals/total								
Mean	0.20	0.33	0.35	0.56	0.31	0.17	0.21	0.27
SD	0.13	0.17	0.15	0.96	0.96	0.09	0.12	0.11
χ^2 (condition)	$(2, N = 42) = 15.02$			$(1, N = 24) = 0.94$			$(2, N = 42) = 5.91$	
$p \leq$	.01			.33			.05	
χ^2 (problem)	$(2, N = 42) = 0.94$			$(1, N = 24) = 3.43$			$(2, N = 42) = 1.74$	
$p \leq$	n.s.			.06			n.s.	
χ^2 (condition × problem)	$(4, N = 42) = 1.40$			$(1, N = 24) = 1.25$			$(4, N = 42) = 1.75$	
$p \leq$	n.s.			n.s.			n.s.	
Participation inequality[d]								
Mean	6.53	1.65	3.24	3.89	3.02	12.32	6.59	4.87
SD	4.43	1.73	2.69	2.56	2.04	10.10	4.31	3.61
χ^2 (condition)	$(2, N = 42) = 19.5$			$(1, N = 24) = 1.5$			$(2, N = 36) = 12.1$	
$p \leq$	.01			n.s.			.01	
χ^2 (problem)	$(2, N = 42) = 3.4$			$(1, N = 24) = 2.14$			$(2, N = 36) = 2.20$	
$p \leq$	n.s.			n.s.			n.s.	
χ^2 (condition × problem)	$(4, N = 42) = 12.37$			$(1, N = 24) = 0.02$			$(4, N = 36) = 2.75$	
$p \leq$	.05			n.s.			n.s.	

TABLE 2—*Continued*

Measures	Experiment 1			Experiment 2		Experiment 3		
	FF	CCN	CCA	SIM	SEQ	FF	CCN	EM
Summary inequality score[e]	0.281	0.116	0.172	0.181	0.136	0.231	0.203	0.207
Interpersonal behavior								
Uninhibited remarks[f]								
Mean	0	0.119	0.429	0.556	0.306	0.289	1.02	0.400
SD	0	0.281	0.561	0.957	0.361	0.434	1.51	0.789
χ^2 (condition)	$(2,N = 42) = 13.3$			$(1,N = 24) = 1.12$			$(2,N = 45) = 2.85$	
$p \leqslant$	.01			n.s.			n.s.	
χ^2 (problem)	$(2,N = 42) = 13.3$			$(1,N = 24) = 2.94$			$(2,N = 45) = 4.23$	
$p \leqslant$	.01			n.s.			n.s.	
χ^2 (condition $\times$ problem)	$(4,N = 42) = 9.55$			$(2,N = 24) = 2.32$			$(4,N = 45) = 3.412$	
$p \leqslant$	.05			n.s.			n.s.	

Consensus development								
Decision shifts[g]								
Mean	0.63	1.22	1.15	0.81	0.89	0.64	1.34	1.01
SD	0.76	0.98	0.85	0.83	0.46	0.46	0.92	0.61
χ^2 (condition)	$(2,N = 54) = 6.0$			$(1,N = 24) = 0.16$			$(2,N = 54) = 12.9$	
$p \leq$	.05			n.s.			.01	
χ^2 (problem)	$(2,N = 54) = 2.04$			$(1,N = 24) = 0.04$			$(2,N = 54) = 2.39$	
$p \leq$	n.s.			n.s.			n.s.	
χ^2 (condition × problem)	$(4,N = 54) = 8.38$			$(1,N = 24) = 0.01$			$(4,N = 54) = 19.28$	
$p \leq$	n.s.			n.s.			.01	

Note. All analyses are based on analysis of variance models with condition effects, problem effects, and their interactions. These analyses were evaluated at the group, not the individual, level. The reported N's are the number of groups (18, 12, and 18 in Experiments 1–3, respectively) times the number of conditions (or number of repeated measures, three for Experiments 1 and 3, two for Experiment 2). The N's are not always equal to their maximum possible values (54, 24, and 54 for Experiments 1–3, respectively) because some data were lost (see text). Communication condition key: FF = Face-to-face; CCN = Computer, nonanonymous; CCA = Computer, anonymous; SIM = Computer, simultaneous; SEQ = Computer, sequential; EM = Computer, electronic mail.

[a] In fractions of an hour.

[b] Average number of remarks within groups.

[c] Average number of task-oriented remarks within groups divided by total remarks.

[d] Group average of the standard deviations of the number of remarks. Larger values reflect less equality.

[e] Average relative standard deviation of group members' participation rates.

[f] Number of remarks within groups.

[g] Absolute difference scores (average individual positive minus the group decision score). Larger values reflect more choice shift.

ipation, interpersonal behavior, and group choice. Communication efficiency, by two measures, was generally lower in the computer-mediated conditions. That is, group members took more time to reach a decision in the computer-mediated conditions, $\chi^2(2,N = 48) = 16.7$, $p < .01$, and group members exchanged fewer remarks in the computer-mediated conditions than in the face-to-face communication condition, $\chi^2(2,N = 42) = 12.8$, $p < .01$. Judging by the results of our third measure, these effects cannot be blamed on lack of effort. That is, groups using the computer to communicate were as task-oriented as when they met face-to-face (the percentage of task-oriented remarks in computer-mediated conditions was 73.5% and in the face-to-face condition, 67%). Finally, our fourth measure showed that computer-mediated groups were efficient in the sense that they communicated more decision proposals as a fraction of all the remarks they made, $\chi^2(2,N = 42) = 15.02$, $p < .01$. The correlation between the proportion of decision proposals and choice shift in groups was low, which suggests that the relative frequency of these proposals does not influence choice shift.

As we predicted, groups communicating via computer showed more equal participation among group members than did face-to-face groups. This conclusion is based on the measure of inequality of participation consisting of each group's standard deviation of individual remarks, where a lower score means more equality. In face-to-face groups, average inequality was 6.53, whereas in the computer-mediated conditions, the average inequality scores were 1.65 (nonanonymous) and 3.24 (anonymous), $\chi^2(2,N = 42) = 19.5$, $p < .01$. The average relative standard deviation of group members' participation rates, our summary measure of inequality which controls for total number of remarks, was 0.28 when groups met face-to-face, whereas the average inequality score was 0.14 when groups met via computer.

The next main finding was that groups using the computer to communicate were more uninhibited than were the same groups communicating face-to-face. Using our measure of uninhibited behavior, that is, counting instances of swearing, insults, and name-calling, we found 34 such instances in the computer-mediated discussions and none in the face-to-face discussions, $\chi^2(2,N = 42) = 13.3$, $p < .01$.[4]

Finally, we found that when they communicated using the computer, groups made decisions that, compared to their decisions in face-to-face discussion, deviated further from their initial, individual opinions. In the computer-mediated condition, choice shift averaged 0.63 whereas in the

[4] Some illustrative quotations from the computer-mediated discussions: "TTy 104 move your fingers!! What the hell is the matter with a social life?" "3/10 from you, you ninny," "What the f...'s wrong with 6 in 10?" "That's the first good idea you've had yet."

computer-mediated conditions, choice shift averaged 1.22 (nonanonymous) and 1.15 (anonymous), $\chi^2(2, N = 42)$ 6.0, $p < .05$.

We carried out several post hoc analyses to examine such potential influences on decisions as extreme position proposals (e.g., a group member proposes an extreme position or a high-risk strategy), dominant group members, and decision rules. In the first case, we coded the number of times group members mentioned the risk values 1 and 9 (very high and very low risk, respectively), and we compared these values (alone, and in combination) across communication conditions and, again, across group members ranked according to their participation in the group. We also evaluated the relationship of the extremity of both initial preferences and of early proposals to choice shift. We found no consistent pattern associating extreme positions with communication condition or with group participation. We also found no relationship between either the proposals or participation rate of the most dominant (highest participating) group member and group choice. For evaluating the relation of decision rules to choice shift, we calculated the number of times that group choice was equivalent to a simple averaging of initial positions and the number of times that group choice was equivalent to accepting a strict majority rule (the choice equals the preferences of two out of the three group members). We found an insignificant tendency for face-to-face groups to use simple averaging (20% of the groups versus 9% and 13% in the computer-mediated groups) and very little overall use of strict majority rule, as we defined it (6% in face-to-face groups; 7% and 2% in computer-mediated groups). These data suggest that decision rules were not applied differentially across communication conditions, but we did not actually measure how groups used decision rules during their discussions.

In summary, the results of this experiment suggest that groups using computer-mediated communication to reach consensus, as compared with groups using face-to-face discussions, experience some inefficiencies in communicating, participate more equally within the group, are more uninhibited, and reach decisions which deviate further from initial individual preferences. These findings are consistent with our ideas about the potential effects of a communication medium which increases focus of attention on messages, which reduces the ability to communicate social and personal feedback, and which depersonalizes the situation.

There is, however, another way of thinking about the behavior we observed. From the perspective of a human factors professional or system designer, any computer-mediated communication mode which changes behavior ought at least to be suspected as "unfriendly" to the user. Indeed, the communication programs we used did involve typing rather than talking, watching the cursor leap about (without the ability to con-

trol it), and trying to read and type at the same time (no turn taking). It is possible that these difficulties distracted or frustrated group members and caused them difficulty in reaching agreement and provoked more uninhibited behavior. The possibility that computer-mediated communication is simply a technically awkward medium (and not social psychologically significant) led us to design and conduct the second experiment. In this case, we developed a modified version of the Converse software and provided practice opportunities to subjects to be sure they were acquainted with the routine. Then we designed the experiment to compare group communications using two computer-mediated communication programs. One program was the same interactive, simultaneous communication conversation program we had used in the first experiment. The other program provided for interactive sequential communication and subject-initiated control over turn taking (i.e., group members controlled the cursor one at a time; they could request use of the cursor, and they could signal when they were ready to relinquish the cursor to another group member). We expected that with this program and better trained subjects, the computer-mediated discussion would run more smoothly and, as a result, obviate the social psychological effects we observed in the first experiment.

EXPERIMENT 2

Method

Subjects. Thirty-six undergraduate students (22 males and 14 females) were volunteers for this experiment. They were scheduled in groups of 3 and randomly assigned to one of three locations on the university campus where there were normal computing environments.

Design and procedure. The design of this study was a 2 × 2 (mode of communication × problem) repeated measures Latin square, with computer mode and problem balanced separately but not jointly. We took special care to instruct subjects in this experiment and we gave them 20-min practice sessions using the computer conversation programs before they started the experiment. Also, we allowed more time for groups to reach consensus on each problem (30 min instead of 20 min) to remove any sense of time pressure subjects might be experiencing. Otherwise the procedure was the same as that employed in Experiment 1.

Because our main purpose was to replicate Experiment 1 using a computer-mediated communication situation which increased the formality and procedural structure of the group discussion, the alternative computer conference program forced group members to take turns speaking and to indicate to others when they wished to interrupt. In the standard program, the software allows all three persons to communicate simulta-

neously. The new program allowed only one person to speak at a time. If someone else controlled the cursor, the group member who wished to say something depressed the control key designated to interrupt—equivalent to raising one's hand in a meeting or saying "Excuse me." The speaker could depress a release control key to permit the other to talk, or could continue to hold the floor (as some did). After the experiment, the subjects completed a questionnaire designed to elicit their subjective experiences with the two programs.

Results

The groups in this experiment changed some aspects of their verbal behavior when they used the new sequential discussion program. They made more remarks about how to organize the discussion (e.g., requests for others to take turns); some speakers refused to relinquish the cursor; group members made fewer suggestions to compromise and fewer remarks which contained or supported others' positions. Group members preferred the simultaneous discussion program, 60% to 30%.

In spite of the differences in the technology, the two computer-mediated conditions in this experiment produced essentially the same decision-making outcomes. Furthermore, where the data are comparable, the results of this experiment paralleled those in the first experiment. (The communication efficiency means are higher than in Experiment 1 because we gave groups more time to reach consensus.) The data and summary statistics from this experiment are contained in Table 2.

The results of this experiment support our belief that computer-mediated communication has social psychological impact which is relatively robust with respect to software variations in communication program. However, greater generalizability would result from a study which compared simultaneous computer-mediated communication with a more common form of computerized communication, that is, computer mail.

EXPERIMENT 3

Computer mail is widely used in organizations having time-shared computer systems and computer networks. Like simultaneous computer conferences, computer mail systems transmit messages quickly, and they are geographically flexible. In addition, computer mail has several technical advantages over simultaneous computer conferences for long-distance group work in organizations. First, computer mail has an easily-accessed memory (senders and receivers may store messages), hence does not require communication in real time. Second, at the message level, there is considerable flexibility for editing and reediting text, and for designating recipients (part of the group, the whole group, or people outside the group). Much larger groups can work together using computer mail

than can work together using simultaneous computer conferences. Finally, computer mail can be adapted to, or used with, special programs for continuing group interaction through distribution lists, bulletin boards, and sequential computer conferences.

Apart from its greater convenience, will computer mail have the same effects on group decision-making as simultaneous computer conferences seem to have? On the one hand, computer mail is much like simultaneous computer conferences in some ways that we initially thought might affect groups. First, nonverbal cues and social artifacts are absent. Second, shared norms for communicating in this medium are absent or weak. On the other hand, computer mail leaves more discretion for reflection and for composing one's thoughts than simultaneous computer-mediated communication does. This might increase the ability of group members to communicate their ideas and feelings, and to use words as a substitute for nonverbal cues, hence to convey social cues and to personalize the communication setting. The purpose of this study was to examine the impact of computer mail on group decision making while at the same time attempting replication of the previous experiments.

Method

Subjects. As in the first experiment, 54 undergraduate students (31 males and 23 females) took part in the study. All of them had used the computer network and one of its computer mail programs (MS).

Design and procedure. The design of the experiment was a 3 × 3 repeated measures Latin square, with three decision communication conditions (face-to-face, simultaneous computer conference, computer mail) and three choice problems. The procedure was the same as that used in the first experiment, except that, as in the second experiment, 30 min were allowed for reaching a consensus.

In the computer mail condition the group members used a standard university computer mail system to communicate with each other about the group decision. Group members type MM> to start the program. Then at any time they can type a variety of commands, such as "?" (to get help), "send," "read," "reply," and "headers" (to list who has sent messages and the subject of the messages). "Send" starts the procedure for sending a message. The program asks the sender for the identities of recipients, for the subject of the message, and for the text of the message, which may or may not be edited. (There are other options such as specifying blind carbon copies, but they were not used by the subjects in this experiment.) When the message is ready, the sender types a specified key to send it off. Recipients then receive a notice on their terminal screens that they have received a message, and can command "read" to see it. Recipients can reply immediately, store the message, delete it, or look at

other messages, all with simple commands. In this experiment, we reviewed the computer mail program for subjects, but virtually all of them were familiar with the available options.

Results

The data from this experiment are described in Table 2. As in Experiment 1, groups using face-to-face discussion took less time to reach a decision, $\chi^2(2,N = 54) = 42.9$, $p < .01$, but they made more remarks, $\chi^2(2,N = 48) = 15.8$, $p < .01$, than they made when using either of the computer-mediated communication modes. Allowing for the greater time permitted groups in the last two experiments, the results across experiments are consistent. Once again, it did not seem as though the differences in communication efficiency could be explained by differences in task orientation. Groups using computer mail were about as task-oriented as face-to-face groups; 97% of face-to-face group discussion was task-oriented (the highest found in any of the experiments) versus 96% in computer mail mode, while 83% of simultaneous computer conferences were task-oriented. Once again, we found that proportionately more of their remarks contained decision proposals when groups used the computer to communicate.

As also may be seen in Table 2, computer-mediated communication led to more equal participation than did face-to-face communication, according to our standard deviation measure; the face-to-face mean was 12.32 whereas the computer conference mean was 6.59 and the computer mail mean was 4.87, $\chi^2(2,N = 36) = 12.1$, $p < .01$. The summary inequality score averages were 0.23 in face-to-face communication and 0.21 in computer-mediated conferencing and computer mail communication.

Members of groups using the computer to communicate also showed some uninhibited behavior in this experiment, as they did in the previous two studies. However, when groups used computer mail, the incidence of uninhibited behavior was less than it was in simultaneously communicating computer-mediated groups (see Table 2). This suggests that the opportunity for reflection in computer mail may reduce "deindividuated" responses.

Finally, we found that choice shift was greater when groups used the computer to communicate than when they met face-to-face, as in the previous experiments. Indeed, as is shown in Table 2, the means for face-to-face and computer conferencing are similar to those elicited in Experiment 1, that is, 0.64 and 1.34, respectively; the mean for computer mail was 1.01, $\chi^2(2,N = 54) = 12.9$, $p < .01$. Neither form or frequency of extreme arguments, nor simple decision rules, accounted for these differences among conditions. (Simple averaging was used by 9% of face-to-face groups, and 11% of computer-mediated groups; strict majority rule

was used by 2% of face-to-face groups, and 6.5% of computer-mediated groups.)

DISCUSSION

In order to show our main results clearly, we have illustrated them in Fig. 2. The data in Fig. 2 suggest that the same group will make decisions differently when group members discuss the issues using computer-mediated communication rather than in face-to-face meetings. We have presented some ideas about the technical and social characteristics of computer-mediated communication which might produce these effects, but we did not test mediating factors directly. Below, we discuss how both trivial and nontrivial mediating factors might limit or explain our results, and we suggest some directions for future research.

At the outset, our findings on communication efficiency have at least one obvious explanation based on the fact that typing and reading are physically more time consuming than are speaking and listening. We tried to examine the role of typing, alone, in the group discussion. For this purpose, we asked 10 students to say aloud and to type into a computer file the same speech. We found that typing might have accounted for about 40% of the difference in number of remarks between face-to-face and computer-mediated communication. However, we did not pursue this point further because of the inherent difficulty of experimentally testing the physical (but not social) effects of typing spontaneously vs speaking spontaneously on the same topics. We cannot rule out the possibility that computer-mediated communication would be as efficient as face-to-face communication if group members did not have to type and read messages.

Given that computer-mediated communication was inefficient by the criteria of time to decision and remarks exchanged during that time, we can offer an explanation of why groups using the computer were relatively task oriented and made more decision proposals as a fraction of their total remarks. Suppose a group member finds it awkward to exchange a full complement of arguments by typing and reading, but that he is motivated to do so. A way to get his main argument across in few keystrokes would be to state his preference outright. In support, the proportion of decision proposals was uncorrelated with social equalization and choice shift. But, the proportion of decision proposals was inversely correlated with time to consensus (−.21), and with measures of verbal behavior: the total number of remarks (−.47), with task-oriented remarks (−.38), and with uninhibited remarks (−.16).

What is lacking in our research, and what would be an interesting direction for future research, is any clear sense of how decision tasks vary in the extent to which they benefit or suffer inefficiencies as a result of using computers to communicate. Some group decision tasks, for ex-

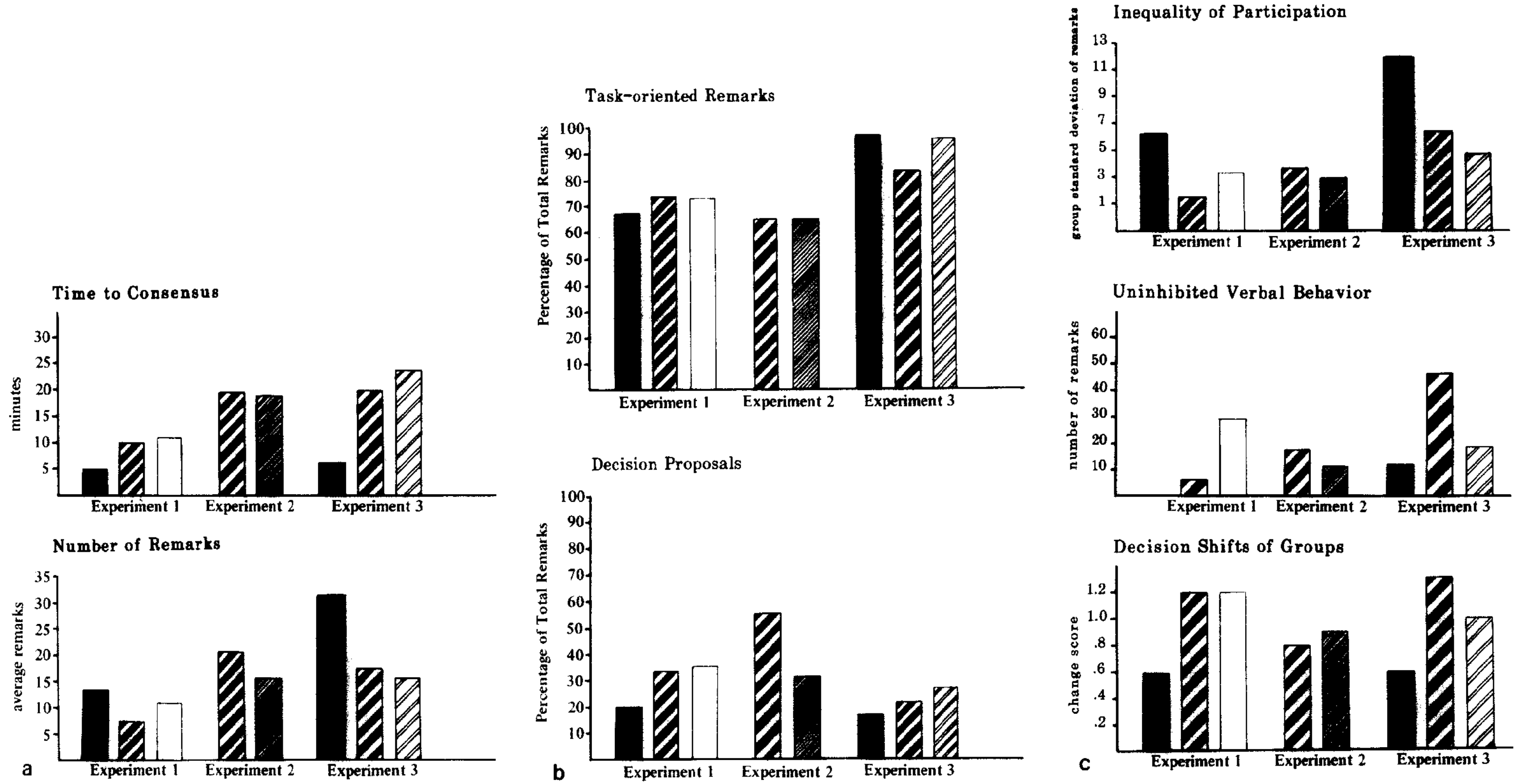

FIG. 2. Communication efficiency (time to consensus and number of remarks (a), task-oriented remarks/total remarks and decision proposals/total remarks, (b) and inequality of participation, uninhibited verbal behavior, and decision shifts of groups (c) in three experiments having various conditions. ■, Face to face; ▨, computer mail; ▨, sequential nonanonymous; □, simultaneous anonymous; ▨, simultaneous nonanonymous.

ample, those in which groups have reason to explore minority opinions fully, will probably take longer (and take more effort) when communication is by computer rather than face-to-face. Other group decision tasks, for example, those in which groups have merely to hear a correct answer to accept it, will probably take less time and effort when communication is by computer.

Another question is whether computer-mediated communication efficiency will vary with differences in group member relationships. For example, acquaintanceship presumably increases knowledge of others, which might reduce the need for group discussion. We did not examine this possibility in that all of our subjects were unacquainted, and we plan to do so in future work.

We believe that our social equalization, interpersonal behavior, and choice shift findings are more interesting from a social psychological perspective. At least three well-studied social psychological processes may be implicated in these findings: shift of attentional focus effects, deindividuation effects, and conformity effects.

Attentional focus may be important if computer-mediated communication focuses attention on constructing and responding to verbal messages rather than on the social context. This would reduce concern about how others will react and about one's own behavior in relation to social norms. Such reduced sociability would be expected to cause even deeper absorption in immediate cues (the content of messages), as well as less caring about others, and behavior that is relatively antinormative, unrestrained, and unregulated (Carver *et al.,* 1981, pp. 171–176). Consistent with this observation, it has been reported that patients reveal more symptoms in a computer-mediated diagnostic session than they do in face-to-face sessions with physicians (Klein, Greist, & Van Cura, 1973).

Heightened self-consciousness has been shown to increase the salience of arousal or affective feelings. When these feelings, rather than personal or social standards of behavior, are the focus of attention, extreme behaviors toward others (such as insulting people) may increase (Scheier & Carver, 1977; Scheier, 1976; Scheier, Carver, & Gibbons, 1981). We believe that using computers to communicate may increase self-absorption in manipulating and responding to message texts. The previous research suggests that if the text in computer messages provokes affect, then behavior in response to that affect will be exacerbated. More generally, the prediction of greater or lesser social equalization, uninhibited behavior, and group decisional shifts in computer-mediated communication might hinge on where attention is directed by it, such as away from internalized social standards, toward current messages, or away from the behavior of others.

An alternative process may be deindividuation. Previous analyses of deindividuation have emphasized the way submergence in a group, social

anonymity, and lowered salience of social controls or standards lead to feelings of loss of identity and uninhibited behavior, such as antinormative aggression or, on the prosocial side, altruism (Diener, 1979; Johnson & Downing, 1979; Prentice-Dunn & Rogers, 1979). Our study suggests that submergence in a technology, and technologically-induced anonymity and weak social feedback might also lead to feelings of loss of identity and uninhibited behavior. Researchers have not yet examined the possibility that deindividuation might result from attachment or absorption in something other than a group, but what might we predict? From our perspective, people who are absorbed in computer-mediated communication might become "deindividuated," leading not just to uninhibited verbal behavior and more equal participation but to other effects we have not yet examined, such as communication across status boundaries.

Conformity effects may account for some of the behavior we observed. We have already claimed that an etiquette for communicating by computer is not well established. On the other hand, computerized communication is embedded in a distinctive subculture of computing which rejects conventionality and social restrictions (e.g., Kidder, 1981). At our university, people who use the computer networks frequently overstep the boundaries between office and home, work and nonwork, formal and informal communication, language appropriate for the boardroom and for the ball field. People who would never read others' U.S. Postal mail will peer over the shoulder of colleagues engaged in scanning their computer mail at a terminal and read the contents. These behaviors suggest that some effects of computer-mediated communication, particularly uninhibited behavior, may have to do with exposure to the computing subculture.

How do our results speak to the existing experimental literature on the behavioral and social results of using modern computers? This research, as far as we know, consists of a few experiments on the affective (arousal) consequences of modern computing, experimental demonstrations of computer networks carried out by Hiltz and Turoff and their colleagues, and the studies of Greist and his colleagues on computer-mediated diagnostic interviews. The studies of affect seem to indicate that computing, by itself, has no direct affective consequences (Grandjean & Vigliani, 1980), but an experiment we conducted recently (Kiesler *et al.*, 1983) suggests that using computers for nonroutine tasks, such as conversing and sending mail, increases expressive behavior and decreases interpersonal attraction toward a stranger relative to face-to-face interaction. The most relevant work of Hiltz is an experiment by Hiltz *et al.* (1980), which though conducted independently of ours, also compared face-to-face with computerized conferences. These authors report their five-person computer-mediated groups exchanged fewer "communica-

tion units," participated more equally, were less likely to reach "total consensus," and reached decisions whose quality was not less good than those of face-to-face groups. The first two findings, of course, are similar to ours. We have already mentioned the work indicating that computer-mediated communication may increase self-disclosure (Greist, Klein, & Van Cura, 1973; Greist, Klein, & Erdman, 1976); if self-disclosure is indicative of lowered self-regulation, these findings are in agreement with ours. So, in general, our results are not inconsistent with data from the few previous experiments that have been carried out.

As computer networks proliferate, group decision making by people who are not in face-to-face contact will be more common than it is today. Much of the literature on using computers for communication, including both analytic articles written for professional computer users and reports of empirical research on computing, does not address the issue of how using a computer might influence the way groups communicate or the way people respond to the communications of others. For example, it is widely claimed that computer mail systems will provide people with more information in a more timely and convenient manner (e.g., Crawford, 1982). As a result, computer-mediated communication is expected to lead to better decisions and actions, and higher productivity (e.g., Price, 1975; Tapscott, 1982). The underlying assumption is that people do not respond differently to information transmitted using a computer. Hence, if decisions can be informed more fully with no increase in financial cost, the decision will be better. And if more people participate in decisions (because more of them are linked conveniently together) and everyone has access to more information, decision making will not only be improved, but will be more democratic as well (Martino, 1972; Rohrbaugh & Wehr, 1978). Our data suggest, however, that people's responses to communication situations should not be considered a constant in these analyses; rather, the same people will respond differently in different communication settings. Thus, while our study was not addressed to the effects of linking many people together electronically, nor to decision making in the larger organizational setting, our findings suggest that the effects of computer-mediated communication on organizational decision making and problem solving may be more complex than has been assumed previously.

REFERENCES

Bales, R., Strodtbeck, F. L., Mills, T. M., & Roseborough, M. E. (1951). Channels of communication in small groups. *American Sociological Review*, **16**, 461–468.

Bikson, T. K., & Gutek, B. A. (1983). Advanced office systems: An empirical look at utilization and satisfaction. Santa Monica, CA: Rand Corporation.

Brotz, D. K. (1983). Message system mores: Etiquette in Laurel. *ACM Transactions on Office Information Systems*, 1983, **1**, 179–192.

Carnevale, P. J. E., Pruitt, D. G., & Seilheimer, S. D. (1981). Looking and competing: Ac-

countability and visual access in integrative bargaining. *Journal of Personality and Social Psychology,* **40,** 111–120.

Carver, C. S., & Scheier, M. F. (1981). Attention and self-regulation: A control theory approach to human behavior. New York: Springer-Verlag.

Chaiken, S., & Eagly, A. H. (1983). Communication modality as a determinant of persuasion: The role of communicator salience. *Journal of Personality and Social Psychology,* **45,** 241–256.

Chapanis, A. (1972). Studies in interactive communication: The effects of four communication modes on the behavior of teams during cooperative problem-solving. *Human Factors,* **14,** 487–509.

Christie, B. (1981). *Face to file communication: A psychological approach to information systems.* New York: Wiley.

Crawford, A. B. (1982). Corporate electronic mail—A communication-intensive application of information technology. *Management Information Science Quarterly,* **6,** 1–14.

Cvetkovitch, G., & Baumgardner, S. (1973). The relative influence of discussion group structure and reference group norms. *Journal of Personality and Social Psychology,* **26,** 159–165.

Davis, J. H., Holt, R. W., Spitzer, C. E., & Stasser, G. (1981). The effects of consensus requirements and multiple decisions on mock juror preferences. *Journal of Experimental Social Psychology,* **17,** 1–17.

Davis, J. H., Stasser, G., Spitzer, C. C., & Holt, R. W. (1976). Changes in group members' decision preferences during discussion: An illustration with mock juries. *Journal of Personality and Social Psychology,* **34,** 1177–1187.

Diener, E. (1979). Deindividuation, self-awareness, and disinhibition. *Journal of Personality and Social Psychology,* **37,** 1160–1171.

Dion, K. L. (1978). Why do groups make riskier decisions than individuals? In L. Berkowitz (Ed.), *Group processes.* New York: Academic Press.

Edinger, J. A., & Patterson, M. L. (1985). Nonverbal involvement and social control. *Psychological Bulletin,* **93,** 30–56.

Ekman, P., Friesen, W. V., O'Sullivan, M., & Scherer, K. (1980). Relative importance of face, body, and speech in judgments of personality and affect. *Journal of Personality and Social Psychology,* **38,** 270–277.

Emmett, R. (1982). *Datamation* (p. 48).

Festinger, L. (1950). Informal social communication. *Psychological Review,* **57,** 271–282.

Festinger L., Pepitone, A., & Newcomb, T. (1952). Some consequences of deindividuation in a group. *Journal of Abnormal and Social Psychology,* **47,** 382–389.

Gibbons, F. X., & Wright, R. A. (1981). Motivational biases in causal attributions of arousal. *Journal of Personality and Social Psychology,* **40,** 588–600.

Grandjean, E., & Vigliani, E. (1980). Ergonomic aspects of visual display terminals. *Proceedings of the International Workshop, Milan.* London: Taylor & Francis, Ltd.

Greist, J. H., Klein, M. H., & Erdman, H. P. (1976). Routine on-line psychiatric diagnosis by computer. *American Journal of Psychiatry,* **12,** 1405–1408.

Greist, J. H., Klein, M. H., & Van Cura, L. J. (1973). A computer interview by psychiatric patient target symptoms. *Archives of General Psychiatry,* **29,** 247–253.

Hiltz, S. R. (1982). *On line scientific communities: A case study of the office of the future.* Ablex Press.

Hiltz, S. R., Johnson, K., Aronovitch, C., & Turoff, M. (1980). *Face-to-face vs. computerized conferences: A controlled experiment: Vol. 1. Findings.* Research Rep. No. 12. Newark: New Jersey Institute of Technology.

Hiltz, S. R., & Turoff, M. (1978). *The network nation: Human communication via computer.* Reading, MA: Addison–Wesley.

Humphreys, R., & Berger, J. (1981). Theoretical consequences of the status characteristics formulation. *American Journal of Sociology,* **86,** 953–983.

Jellison, J. M., & Arkin, R. M. (1977). Social comparison of abilities: A self-presentational approach to decision making in groups. In J. Suls & R. Miller (Eds.), *Social comparison processes*. New York: Halsted.

Johansen, R., Vallee, J., & Spangler, K. (1979). *Electronic meetings: Technical alternatives and social choices*. Menlo Park, CA: Addison-Wesley.

Johnson, R. D., & Downing, L. L. (1979). Deindividuation and valence of cues: Effects on prosocial and antisocial behavior. *Journal of Personality and Social Psychology*, **37**, 1532-1538.

Kidder, T. J. (1981). *The soul of a new machine*. New York: Avon Books.

Kiesler, S., Zubrow, D., Moses, A. M., & Geller, V. (1983). *Affect in computer-mediated communication*. Unpublished manuscript, Carnegie-Mellon University, Pittsburgh, PA.

Kogan, N., & Wallach, M. A. (1967). Risky-shift phenomenon in small decision-making groups: A test of the information-exchange hypothesis. *Journal of Experimental Social Psychology*, **3**, 75-84.

Kogan, N., & Wallach, M. A. (1967). Effects of physical separation of group decision-makers upon group risk taking. *Human Relations*, **20**, 41-49.

Krauss, R. M., Apple, W., Morencz, N., Wenzel, C., & Winton, W. (1981). Verbal, vocal, and visible factors in judgments of another's affect. *Journal of Personality and Social Psychology*, **40**, 312-320.

Kraut, R. E., Lewis, S. H., & Swezey, L. W. (1982). Listener responsiveness and the coordination of conversation. *Journal of Personality and Social Psychology*, **43**, 718-731.

Kraut, R. E., & Lewis, S. H. (1984). *Communication by children and adults: Social cognitive and strategic processes*. Beverly Hills: Sage Publications, 231-260.

Lancaster, F. W. (1978). *Toward paperless information systems*. New York: Academic Press.

Lamm, H., & Kogan, N. (1970). Risk-taking in the communication condition of intergroup negotiations. *Journal of Experimental Social Psychology*, **6**, 351-363.

Lamm, H., & Myers, D. G. (1978). Group induced polarization of attitudes and behavior. In L. Berkowitz, (Ed.), *Advances in experimental social psychology*. New York: Academic Press.

Licklider, J. C. R., & Vezza, A. (1978). Applications of information networks. *Proceedings of the IEEE*, **66**, 1330-1346.

Martino, J. P. (1972). *Technological forecasting for decision making*. New York: Amer. Elsevier.

Mehrabian, A. (1972). *Nonverbal communication*. Chicago: Aldine.

Nagao, D. H. (1983). *Normative influence, consensus requirements and the assessment of opinion change in groups*. Presented at the meeting of the American Psychological Association, Anaheim, CA.

Patterson, M. L. (1982). A sequential functional model of nonverbal exchange. *Psychological Review*, **80**, 231-249.

Prentice-Dunn, S., & Rogers, R. W. (1979). Effects of deindividuating situational cues and aggressive models on subjective deindividuation and aggression. *Journal of Personality and Social Psychology*, **39**, 104-113.

Price, C. R. (1975). Conferencing via computer: Cost effective communication of the era of forced choice. In H. A. Linstone & M. Turoff (Eds.), *The Delphi method: Techniques and applications*. Reading, MA: Addison-Wesley.

Pruitt, D. G., & Lewis, S. A. (1975). Development of integrative solutions in bilateral negotiations. *Journal of Personality and Social Psychology*, **31**, 621-633.

Rice, R. E. (1980). The impacts of computer-mediated organizational and interpersonal communication. In M. Williams (Ed.), *Annual Review of Information Science and Technology* (Vol. 15). White Plains, NY: Knowledge Industry Publishers.

Rohrbaugh, J., & Wehr, P. (1978). Judgment analysis in policy formation: A new method for improving public participation. *Public Opinion Quarterly*, **42**, 521–532.

Safire, W. (1983). My dear computer. *The New York Times Magazine*, p. 16.

Scheier, M. F., Carver, C. S., & Gibbons, F. X. (1981). Self-focused attention and reactions to fear. *Journal of Research in Personality*, **15**, 1–15.

Scheier, M. F. (1976). Self-awareness, self-consciousness, and angry aggression. *Journal of Personality*, **44**, 627–644.

Schneiderman, B. (1979). *Software psychology*. Cambridge, MA: Winthrop.

Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications*. London: Wiley.

Sinaiko, H. W. (1963). Teleconferencing: Preliminary experiments. Research Paper P-108, Institute for Defense Analysis, Arlington, VA, NTIS AD-601932.

Stoner, J. A. (1961). *Comparison of individual and group decisions including risk*. Unpublished masters thesis, School of Industrial Management, Massachusetts Institute of Technology.

Tapscott, D. (1982). Investigating the electronic office. *Datamation*, 130–138.

Thomas, J. & Carroll, J. (1981). Human factors in communication. *IBM Systems Journal*, **20**, 237–263.

Turoff, M. (1982a). Delphi conferencing: Computer-based conferencing with anonymity. *Technological Forecasting and Social Change*, **2**.

Turoff, M. (1982b). Interface design in computerized conferencing systems. In *NYU Symposium on User Interfaces*. New York University, Graduate School of Business Administration, Computer Applications and Information Systems.

Vallee, J., Johansen, R., Lipinski, H., & Wilson, T. (1977). *Group communication through computers* (Vol. 4). Menlo Park, CA: Institute of the Future.

Van Gelder, L. (1983). Modems: Close encounters of the computer kind. *Ms Magazine*, **90**, 61–64.

Vinokur, A., & Burnstein, E. (1974). The effects of partially shared persuasive arguments in group-induced shifts: A group-problem-solving approach. *Journal of Personality and Social Psychology*, **29**, 305–315.

Vinokur, A., & Burnstein, E. (1978). Novel argumentation and attitude change: The case of polarization following group discussion. *European Journal of Social Psychology*, **8**, 335–348.

Williams, E. (1975). Medium or message: Communications medium as a determinant of interpersonal evaluation. *Sociometry*, **38**, 119–130.

Williams, E. (1977). Experimental comparisons of face-to-face and mediated communication: A review. *Psychological Bulletin*, **8**, 963–976.

Williams, K. Harkins, S., & Latane, B. (1981). Identifiability as a deterrent to social loafing: Two cheering experiments. *Journal of Personality and Social Psychology*, **40**, 310–311.

Zajonc, R. (1969). Group risk-taking in a two-choice situation: Replication, extension, and a model. *Journal of Experimental Social Psychology*, **5**, 12–140.

Zimbardo, P. G. (1981). The human choice: Individuation, reason and order versus deindividuation, impulse, and chaos. In W. S. Arnold & D. Levine (Eds.), *Nebraska Symposium on Motivation*. Lincoln, Nebraska: Univ. of Nebraska Press. *Psychological Review*, **88**, 523–551.

Zuboff, S. (1982). New worlds of computer-mediated work. *Harvard Business Review*, **60**, 145–152.

RECEIVED: December 27, 1983